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IoT-Based Smart Wearable Device for Remote Tracking & Tranquilization of Elephants Using Android app

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Abstract - This project aims to develop an IoT-based smart wearable gadget for the non-lethal control of domestic elephants during violent or aggressive episodes. Affixed to the elephant's back thigh to prevent damage, the device enables remote tracking and tranquilization via Android app. Traditional tranquilizer guns pose risks such as misfires, limited drug capacity, and potential harm due to imprecise aiming. Our solution integrates an injector mechanism that allows mahouts or elephant owners to administer controlled tranquilization remotely. The app offers multiple dosage levels, ensuring a humane and safer alternative by preventing excessive sedation. Real-time tracking enhances transparency and security, preventing unauthorized movement. This approach simplifies elephant control by eliminating shooting risks, reducing costs, and bypassing the need for government approvals. The system leverages IoT connectivity for seamless communication and status updates. The injector mechanism, developed using advanced 3D printing, is designed with precise pressure and force calculations for safe drug administration. This innovative solution enhances the well-being of elephants while ensuring the safety of their human caretakers, offering a technological breakthrough in humane elephant management.

Key Words: IoT, wearable device, remote monitoring, animal welfare, non-lethal control,

1. INTRODUCTION

As wildlife conservation faces growing challenges, innovative technologies like the Internet of Things (IoT) are revolutionizing efforts to protect endangered species. This project aims to develop an IoT-based smart wearable device for the remote tracking and tranquilization of domestic elephants, enhancing their welfare and safety.

The system includes a wearable device that continuously monitors the elephant's vital signs, location, and behaviour. Data collected is transmitted to a cloud server and accessed via an Android app, enabling caretakers, veterinarians, and conservationists to monitor the elephant's health in real time. The app provides alerts for anomalies, ensuring prompt intervention to prevent potential threats. In emergencies, a tranquilization module can be activated remotely, ensuring safety for both humans and elephants while eliminating risks associated with traditional tranquilization methods.

The successful implementation of this project will improve domestic elephant management by allowing caretakers to provide better care while ensuring humane treatment. By integrating IoT, real-time data monitoring, and remote intervention, this system advances wildlife conservation efforts. It also highlights IoT's potential in tackling complex conservation challenges, paving the way for future technological innovations in animal welfare and management.

2. LITERATURE REVIEW

As we strive to protect the majestic elephant, a creature that has captivated human imagination for centuries, technology has emerged as a powerful ally. Recent studies have explored the application of cutting-edge technologies, including deep learning and IoT, to develop innovative solutions for elephant detection, tracking, and repellent systems. This literature review delves into the findings of three papers that showcase the potential of these technologies in promoting elephant conservation.

Imagine being able to detect the presence of an elephant in a human-dominated area and taking prompt action to prevent potential conflicts. This is the promise of a novel system proposed in the paper "Development of an Elephant Detection and Repellent System based on Efficient Det-Lite Models." By leveraging deep learning-based models, this system can detect elephant presence with high accuracy and deploy a repellent system to deter them from entering human-dominated areas.

But what about the countless elephants that lose their lives on railway tracks every year? Can technology help prevent these tragic accidents? The paper "An IoT-based Monitoring System to Detect Animals in the Railway Track Using Deep Learning Neural Network" proposes an IoT-based monitoring system that uses deep learning neural networks to detect animals, including elephants, on railway tracks. By analyzing data from sensors and cameras, this system can detect animal presence and alert authorities to take prompt action.

Meanwhile, conservationists are working tirelessly to track and monitor elephant movements, often in challenging and remote terrain. The paper "Monitoring & Tracking System for Elephants Using GPS/GSM with Smart Electric Fencing" proposes a monitoring and tracking system that uses GPS/GSM technology and smart electric fencing to track elephant movements and prevent human-wildlife conflict. By enabling

real-time monitoring of elephant locations, this system can help conservationists respond promptly to potential conflicts.

In conclusion, these three papers demonstrate the potential of technology to make a real difference in the lives of elephants. By harnessing the power of deep learning and IoT, we can develop innovative solutions that promote elephant conservation and prevent human-wildlife conflict. As we continue to explore the applications of these technologies, we may uncover even more ways to protect and preserve these incredible creatures.

3. METHODOLOGY

The software component of this system is designed to facilitate real-time tracking and controlled tranquilization of domestic elephants through a cloud-integrated Android application. At its core, the system relies on a Firebase-powered infrastructure to manage data storage, real-time synchronization, and remote command execution. The Android application serves as the primary interface for the elephant's owner or mahout, providing seamless user experience for monitoring and managing the elephant's movements and behavioral status.

Upon launching, the app initializes key modules, including GPS, Wi-Fi, and Firebase, ensuring stable connectivity for data transmission. The user is required to authenticate through an MPIN verification process, enhancing security and preventing unauthorized access. Once authenticated, the user gains access to a tracking dashboard that retrieves the elephant's real-time GPS coordinates from Firebase, displaying its current location and movement history on an interactive map. The system continuously updates these coordinates at set intervals, ensuring that the user has up-to-date information about the elephant's whereabouts.

Beyond tracking, the app incorporates a behavioral monitoring feature that allows the user to assess the elephant's condition based on its movement patterns and status updates. If the elephant exhibits signs of distress or aggressive behaviour, the system prompts the user with an option to initiate a controlled tranquilization process. To ensure safety and prevent accidental activation, the app implements a multi-step authorization mechanism. When the "Tranquilize" button is pressed, the user must re-enter the MPIN for verification. If the credentials match, a "Tranquilize Command" is sent to Firebase, which triggers the execution of the injection process.

The tranquilization status is continuously updated in the Firebase database, ensuring real-time synchronization between the app and the cloud. The user receives immediate feedback on whether the tranquilization process has been successfully initiated, allowing them to monitor the outcome remotely. Additionally, the system includes status notifications and logs, enabling a comprehensive history of tracking data and tranquilization events for future reference. The entire software framework is designed for reliability, security, and ease of use, ensuring a seamless integration of IoT-based monitoring and intervention for effective elephant management.

4. SYSTEM ARCHITECTURE

1) BLOCK DIAGRAM

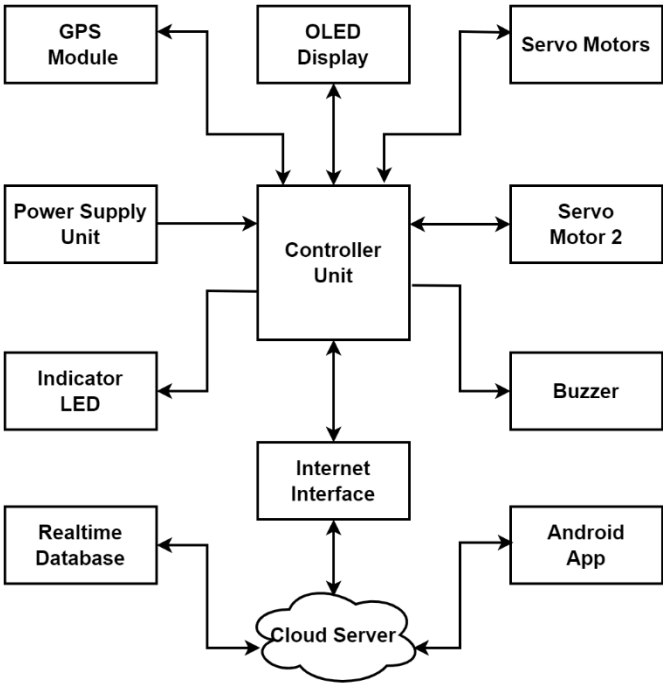

Figure -1: Block diagram

At the core of the system is the Controller Unit, which manages communication between components and executes commands from the Android app. A GPS module continuously tracks the elephant's location, transmitting data to a cloud-based real-time database accessible via the app. An OLED display provides system status updates, including battery level, GPS connectivity, and tranquilization alerts.

For tranquilization, two servo motors control the injection mechanism—one positions the needle, while the other operates the plunger. When a tranquilization command is initiated via the app, the Controller Unit processes the request and activates the motors. Security measures, such as confirmation prompts, prevent accidental injections. An LED indicator and buzzer provide visual and audible alerts for system status.

Powered by a durable supply unit, the system ensures seamless operation in outdoor environments. The Android app enables live GPS tracking, health monitoring, and remote tranquilization control. This IoT-integrated solution enhances elephant safety and management through real-time tracking, cloud storage, and precise tranquilization control.

2) SOFTWARE REQUIREMENTS

We use Kodular for fast, no-code Android app development with a user-friendly design crafted in Adobe Illustrator. Firebase powers real-time data storage, user authentication, and cloud communication, enabling tracking, geofencing alerts, and controlled tranquilization. These technologies ensure efficient, safe, and seamless domestic

elephant management. The detailed analysis of all these software are as follows.

1. **Adobe Illustrator:** Adobe Illustrator plays a key role in designing our Android app's UI, ensuring sharp, clear visuals across all screen sizes. Using Artboards, we create multiple screens for a smooth layout, while tools like the Pen Tool and Shape Builder enable precise custom icons and buttons. Colour and Gradient tools enhance visual appeal, and Illustrator's integration with Adobe XD and Photoshop streamlines prototyping. Assets are exported in PNG, SVG, or WebP for seamless Kodular integration. Features like smart guides, layers, and responsive resizing keep designs organized. Adobe Cloud syncing enables effortless collaboration, ensuring an intuitive, visually appealing, and user-friendly experience for elephant caretakers.

2. **Kodular**: Kodular is a no-code platform based on MIT App Inventor, allowing easy Android app development through a drag-and-drop interface and block-based coding. It enables GPS tracking, Firebase authentication, real-time data updates, and push notifications without complex coding. Pre-built components like buttons, maps, and sensors enhance functionality, while custom extensions expand capabilities. The Kodular Companion app simplifies testing with real-time previews. Its seamless Firebase integration ensures instant data exchange for accurate tracking and alerts. Kodular allows fast, efficient development of a user-friendly app, helping caretakers monitor elephants in real time, improving safety and management without requiring programming expertise.

3. **Firebase server:** Firebase is a cloud-based platform by Google that acts as the backbone of our elephant tracking system, handling everything from real-time data updates to user authentication and instant alerts. Since we need constant monitoring of an elephant's GPS location, health status, and geofencing alerts, Firebase's Realtime Database ensures that any changes—like movement beyond a safe zone or a health warning—are immediately reflected in the app. This means caretakers always have the latest information at their fingertips. Firebase Authentication keeps the system secure by allowing only authorized users to access sensitive controls, such as triggering the tranquilization mechanism when necessary. To send quick notifications about emergencies, Firebase Cloud Messaging (FCM) pushes alerts directly to the app, ensuring immediate action can be taken. Its seamless integration with Kodular makes data handling effortless, eliminating the need for complex backend coding. If we ever expand to a web-based dashboard, Firebase Hosting can support it, while Firebase Analytics provides insights into how the app is being used. With its real-time syncing, strong security, and scalability, the Firebase ensures our system runs smoothly, always keeping both the elephants and their caretakers safe and well-informed.

3) ALGORITHM

Step 1: Initialize GPS, Wi-Fi, and Firebase modules.

Step 2: Set servo motor to initial position (no injection).

Step 3: Check network connection; if connected, proceed; else, retry.

Step 4: Launch Android app; prompt users to enter MPIN.

Step 5: Verify MPIN:

- If correct, grant access to tracking dashboard.

- If incorrect, show error message and prompt again.

Step 6: Continuously acquire GPS coordinates from the elephant's GPS module.

Step 7: Update GPS coordinates to Firebase at set intervals (e.g., every 10 seconds).

Step 8: App retrieves GPS data from Firebase and displays it on a map in real time.

Step 9: Owner/mahout monitors the elephant's behaviour.

Step 10: If the elephant appears agitated or aggressive, proceed to the next step; otherwise, continue location tracking.

Step 11: Display the "Tranquilize" button on app screen when violent behaviour is detected.

Step 12: When the button is pressed, prompt user to re-enter MPIN for confirmation.

Step 13: Check if the re-entered MPIN matches the stored MPIN:

- If correct, send "Tranquilize Command" to Firebase.

- If incorrect, show error message and return to main screen.

Step 14: Tranquilizer system checks Firebase for the "Tranquilize Command."

Step 15: When the command is detected, activate servo motor to initiate drug injection.

Step 16: Servo motor turns to position for injection.

Step 17: Inject the drug dosage and wait briefly to confirm completion.

Step 18: Set servo motor back to its initial position (no injection).

Step 19: Update Firebase with the status "Tranquilizer Activated."

Step 20: App retrieves status from Firebase and displays "Tranquilizer Activated" message.

Step 21: Observe the elephant's condition remotely via the app.

Step 22: If necessary, repeat the tranquilization process with caution.

Step 23: Once the elephant is calm, reset system states and continue location monitoring.

5. WORKING & IMPLMENTATION

The elephant tracking and tranquilization system is developed using Kodular, a visual development platform for building Android applications without extensive coding. Upon launching, the app initializes essential modules, including GPS, Wi-Fi, and Firebase, while setting the servo motor to its default position to prevent accidental drug injections. The system then checks for an active network connection and continuously retries until connectivity is established.

Once connected, the user is prompted to enter an MPIN for authentication. If the MPIN is correct, access is granted to the tracking dashboard; otherwise, the user must re-enter the correct MPIN. The system then begins with real-time GPS tracking, acquiring the elephant's location through a GPS module and updating Firebase at set intervals. The app retrieves this data and displays the elephant's movements on a live map, enabling the owner or mahout to monitor its status remotely.

Behavioral monitoring is a crucial aspect of the system. If the elephant exhibits normal behaviour, location tracking continues as usual. However, if signs of agitation or aggression are detected, the app triggers the next phase. A "Tranquilize" button appears on the screen, allowing the user to initiate the tranquilization process. Before proceeding, the app prompts the user to re-enter the MPIN for confirmation. If the MPIN is incorrect, an error message is displayed, and the process is halted. If correct, the app sends a "Tranquilize Command" to Firebase, which is continuously monitored by the tranquilizer system.

Upon detecting the command, the system activates the servo motor, positioning it for drug injection. The tranquilizer is administered, and the system waits momentarily to confirm successful injection before resetting the servo motor to its original position. The system then updates Firebase with the status "Tranquilizer Activated," which is retrieved and displayed on the app to inform the user. The elephant's condition is observed remotely, and if necessary, the tranquilization process can be repeated cautiously. Once the elephant has calmed down, all system states are reset, and normal GPS tracking resumes.

Since this project is built using Kodular, it leverages its drag-and-drop interface to integrate Firebase Realtime Database for cloud-based data storage and GPS tracking modules for real-time location monitoring. The servo motor and tranquilization system are controlled using IoT components that interact with the app through Firebase commands. Security is enforced using MPIN authentication, and Firebase security rules ensure unauthorized users cannot manipulate data. As the system requires an active internet connection for real-time tracking and tranquilization execution, stable connectivity is essential for its effectiveness.

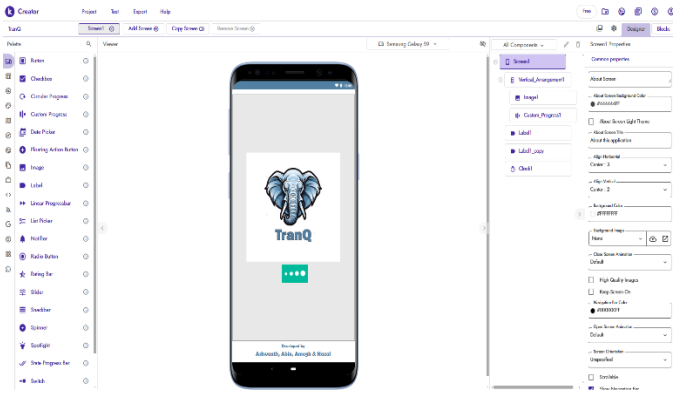

Figure -2: Frontend of the proposed App

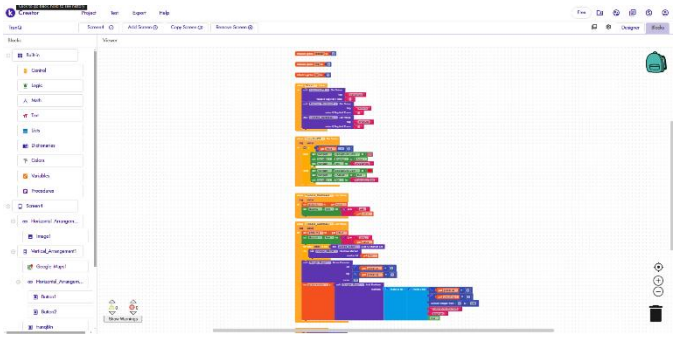

Figure -3: Backend of proposed App

6. CONCLUSIONS

In conclusion, the IoT-based tracking and tranquilizing device for domestic elephants represents a significant advancement in how we care for and manage these remarkable animals. By integrating real-time tracking, health monitoring, and tranquilizer administration into one cohesive system, this project empowers caretakers and handlers to stay informed about the elephants' movements. This proactive approach not only helps prevent conflicts but also enhances safety for both the elephants and the communities that interact with them. The tranquilizer delivery system allows for quick and humane responses in emergencies, ensuring that the well-being of these domesticated elephants remains a top priority.

What makes this project particularly exciting is its innovative design, which can serve as a model for similar initiatives in regions where domestic elephants are integral to local culture and livelihoods. As we continue to refine this technology, the possibilities for further enhancements are vast, from incorporating machine learning to predict behaviour to adding

environmental monitoring features. Ultimately, this project has the potential to transform the management of domestic elephants, fostering a deeper understanding and appreciation for these majestic creatures. By promoting positive human-animal relationships, it paves the way for a future where domestic elephants can thrive alongside the communities that cherish them, making it a vital contribution to animal care and conservation efforts in India and beyond.

7. REFERENCES

[1] S.Pemasinghe and P.K.Abeygunawardhana,"Development of an elephant detection and repellent system based on efficient models," in 2023 International Conference for Advancement in Technology (ICONAT). IEEE, 2023, pp. 1–6.

[2] G. Ramesh, S. Mathi, S. R. Pulari, and V. Krishnamoorthy, "An automated vision-based method to detect elephants for mitigation of human-elephant conflicts", 2017 International Conference on Advances in Computing Communications and Informatics (ICACCI), 2017

[3] S. Chandra et al.Reliability and age of information analysis of 5G IoT for intelligent communication Computers and Electrical Engineering(2022)

[4] A. Delplanque, S. Foucher, P. Lejeune, J. Linchant, and J. Théau, "Multispecies detection and identification of African mammals in aerial imagery using convolutional neural networks," Remote Sensing in Ecology and Conservation, vol. 8, no. 2, pp. 166–179, 2022

[5] E. M. Gross, J. G. Pereira, T. Shaba, S. Bilério, B. Kumchedwa, and S. Lienenlüke, "Exploring routes to coexistence: Developing and testing a human dash; elephant conflict-management framework for African elephant-range countries," Diversity, vol. 14, no. 7, 2022.

[6] Monitoring & Tracking System for Elephants Using GPS/GSM with Smart Electric Fencing To cite this article: K. Rajalashmi et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1084 01206

[7] C.-Y. Wang, A. Bochkovskiy, and H.-Y. M. Liao, "Yolov7: Trainable bag-of freebies set new state-of-the-art for real-time object detectors," in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, 2023, pp. 7464–7475.

[8] Monitoring and controlling electricity consumption using Wemos D1 Mini and smartphone. To cite this article: Wiwid Suryono et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 909 012014.

[9] The development of e-modules using Kodular software with problem-based learning models in momentum and impulse material to cite this article: Muhammad Ridho Syarlisjiswan et al 2021 J. Phys.: Conf. Ser. 1796 012078.

[10] Narayanan L A Jeni, Narayanan C Lakshmi, M S Karthika, S Ramya and R Kaviyaraj, "Railway Tracks and Key Detection Robots Using Iot", 2022.

[11] Avini Nandanwar, Shreedarshan Nanotkar, Sakshi Bhure and Satish Kathane, "Review Paper on Railway Track Crack Detection Robot Using Iot", 2022.

[12] A. Ranjith, S.P. Vijayaragavan and Muthukumaran NirmalraniV, "An Iot based monitoring system to detect animals in the railway tracks using deep learning neural network", *IEEE Xplore*, 2022.

[13] Roshan R. Kolte, Prajakta D. Chandole, Neha S. Chandekar, Anushree S. Mate, Muskan P. Sheikh and Shrushti R. Lakhe, *FTS: File Tracking System for Railway Board" ljraset journal*, 2021